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NATIONAL DAM SAFETY PROGRAM. R. HAAS & A. HECK DAM (MO 30526), --ETC(U)

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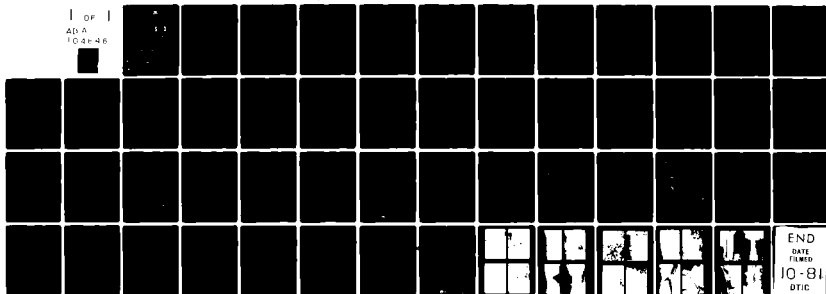
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R. HAAS & A. HECK DAM
CRAWFORD COUNTY, MISSOURI
MO 30526

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PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: R. Haas & A. Heck Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the R. Haas & A. Heck Lake Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure
- 3) Dam failure significantly increases the hazard to loss of life downstream

SIGNED

18 SEP 1979

SUBMITTED BY: _____
Chief, Engineering Division

Date

SIGNED

APPROVED BY: _____
Colonel, CE, District Engineer

18 SEP 1979

Date

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R. HAAS & A. HECK LAKE DAM
CRAWFORD COUNTY, MISSOURI
MISSOURI INVENTORY NO. 30526

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

September 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	R. Haas & A. Heck Lake Dam
State Located:	Missouri
County Located:	Crawford
Stream:	Tributary of Shoal Creek
Date of Inspection:	26 June 1979

R. Haas & A. Heck Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

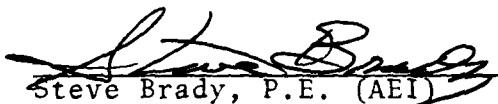
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 1 mile downstream of the dam. Located within this zone are three dwellings and two roads. The dam is in the small size classification, since the maximum storage capacity is greater than 50 ac-ft but less than 1000 ac-ft.

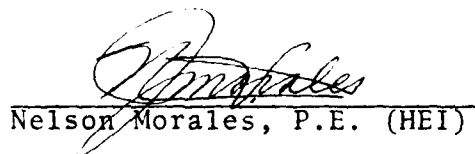
Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 6 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the small size of the dam, the low storage impoundment capacity of the reservoir

and the large floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The 100-year frequency flood will overtop the dam. The 100-year flood is one that has a 1 percent chance of being exceeded or equaled in any given year. The 10-year frequency flood will not overtop the dam. The 10-year flood is one that has a 10 percent chance of being exceeded or equaled in any given year.

Deficiencies visually observed by the inspection team were: (1) significant erosion and sloughing of downstream face of embankment; (2) heavy tree and brush growth on dam; (3) lack of wave protection for upstream face of dam; (4) brush and debris in approach channel to the south spillway; (5) some cracking of concrete in spillways; (6) leakage under the north spillway; and (7) brush and debris in discharge channels of spillways. Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action in the very near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


Steve Brady, P.E. (AEI)


Nelson Morales, P.E. (HEI)


Tom Beckley, P.E. (AEI)


Dave Daniels, P.E. (HEI)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
R. Haas & A. Heck Lake Dam - ID No. 30526

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of the Project	1
1.3	Pertinent Data	3
	SECTION 2 - ENGINEERING DATA	
2.1	Design	6
2.2	Construction	7
2.3	Operation and Maintenance	7
2.4	Evaluation	8
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	9
3.2	Evaluation	10
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	11
4.2	Maintenance of Dam	11
4.3	Maintenance of Operating Facilities	11
4.4	Description of Any Warning System in Effect	11
4.5	Evaluation	11
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	12
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	14
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	15
7.2	Remedial Measures	16

APPENDICES

	<u>Sheet</u>
APPENDIX A	
Location Map	1
Vicinity Map	2
Plan, Profile and Section of Dam	3
Plan Sketch of Dam	4
APPENDIX B	
Geologic Regions of Missouri	1
Thickness of Loessial Deposits	2
APPENDIX C	
Overtopping Analysis - PMF	1-8
APPENDIX D	
Photographs of Dam and Lake	1-5

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of R. Haas & A. Heck Lake Dam in Crawford County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

R. Haas & A. Heck Lake Dam is an earth fill structure approximately 16 ft high and 360 ft long at the crest. The appurtenant works include: (1) a spillway consisting of a 2 ft-11 in. by 4 ft-10 in. concrete box culvert and a 22 in. diameter steel pipe located at the south end of the dam, and (2) a spillway located at the north end of the dam which consists of three 22 in. diameter steel pipes. These spillways, although located at opposite ends of the dam, are at nearly the same elevation. Therefore, neither can be considered an emergency spillway. In addition, an uncontrolled 2 in. diameter steel pipe passes through the dam and flows constantly. Sheet 3 of Appendix A shows a plan profile and typical section of the embankment.

B. Location:

The dam is located in the southeastern part of Crawford County, Missouri on a tributary of Shoal Creek. The dam and lake are within the Davisville, Missouri 7.5 minute quadrangle sheet (Section 3, T35N, R2W - latitude $37^{\circ} 46.53'$; longitude $91^{\circ} 08.02'$). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 16 ft and a maximum storage capacity of approximately 60 acre-ft, the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 1 mile downstream of the dam. Located within this zone are three dwellings and two roads.

E. Ownership:

The dam is owned by Mr. Robert Haas and Mr. August Heck. The owners' address is Star Route 286, Box 18, Viburnum, Missouri 65566.

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes, although some flood protection is also provided.

G. Design and Construction History:

No design information is available. The owners indicated that the dam was constructed in about 1965, but plans for construction are not available. The present owners purchased the dam and lake in 1967. The three steel pipes at the north end of the dam were installed about 1969. In about 1970, the box culvert and steel pipe were installed at the south end of the dam. No problems of seepage through the dam are reported to have occurred. Some sloughing of the downstream face occurred after overtopping in the early 1970's. A pond was constructed immediately downstream of the dam in about 1974.

H. Normal Operating Procedures:

All flows will be passed by uncontrolled culvert spillways. Information from the owners indicates that the dam has been overtopped twice since they have owned it. The most recent overtopping occurred in April 1979.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 721 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through uncontrolled spillways.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 101.0): 359 cfs
- (3) Estimated Capacity of Primary Spillways: 359 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: greater than 359 cfs (overtopped).
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an elevation of 100.0 for the top of the northeast corner of the north concrete culvert (see Sheet 3, Appendix A).

- (1) Top of Dam: 101.0 (Low Point); 101.2 (High Point)
- (2) South Spillway Crest: 97.0
- (3) North Spillway Crest: 97.1
- (4) Principal Outlet Pipe Invert: Not Applicable
- (5) Streambed at Centerline of Dam: 85.2
- (6) Pool on Date of Inspection: 97.2
- (7) Apparent High Water Mark: Above Top of Dam
- (8) Maximum Tailwater: Unknown
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 2000 ft
- (2) At Spillway Crest: 830 ft

E. Storage Capacities:

- (1) At Spillway Crest: 20 acre-ft
- (2) At Top of Dam: 60 acre-ft

F. Reservoir Surface Areas:

- (1) At Spillway Crest: 5 acres
- (2) At Top of Dam: 13 acres

G. Dam:

- (1) Type: Earth
- (2) Length at Crest: 360 ft
- (3) Height: 16 ft

- (4) Top Width: 11 ft
- (5) Side Slopes: Upstream 1.6:1.0 (from crest to water's edge); Downstream Irregular (See Sheet 3, Appendix A)
- (6) Zoning: Unknown
- (7) Impervious Core: Unknown
- (8) Cutoff: Unknown
- (9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 South Spillway:

- (1) Location: South Abutment
- (2) Type: Pipe and Box Culvert

I.2 North Spillway:

- (1) Location: North Abutment
- (2) Type: Pipe Culvert

J. Regulating Outlets:

There are no regulating facilities associated with this dam. The only dewatering facility is a 2 in. diameter pipe through the base of the dam which apparently flows continuously (no shut-off valve). The maximum flow through this pipe was estimated at 78 gallons per minute. The only evidence of this pipe is an obvious flow of water in the pond at the downstream toe of the dam (see Photo No. 7).

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No design computations or reports for R. Haas & A. Heck Lake Dam are available. No documentations of construction inspection records have been obtained. To our knowledge, there are no documented maintenance data.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. Sheet 3 of Appendix A presents a plan, profile and cross section of the dam from survey data obtained from the site inspection. The top of the northeast corner of the north concrete culvert (emergency spillway) was used as a site datum of assumed elevation 100.00 (see Sheet 3, Appendix A). It is estimated that this site datum approximately corresponds to mean sea level elevation 1040.

B. Geology and Subsurface Materials:

The site is located in the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common bedrock types are dolomite, sandstone and chert.

Information supplied by the Missouri Geological Survey indicates that the bedrock in the valley consists of the Potosi formation of the Cambrian System. The Potosi formation is composed of a massive, thickly bedded, medium-to fine-grained dolomite. Caves, springs, seeps and other solution phenomena are common to the Potosi formation. The publication "Caves of Missouri" lists seven caves known to exist in Crawford County. All but one of these caves are clustered in a 9 square mile area about 17 miles northwest of the site. Caves listed in adjacent counties are greater distances from the site.

The "Geologic Map of Missouri" indicates a normal fault passing about 5 miles north of the site in an east-west direction. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years.

Soils in the area of the dam site appear to be primarily thin deposits of residual silty clays with rock fragments. The soils are of the Clarksville-Fullerton-Talbott Soil Association and have developed from thin

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on June 26, 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Nelson Morales - Hanson Engineers, Inc. (Hydraulic Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

B. Dam:

The dam appears to be generally in poor condition. Significant erosion and sloughing has occurred on the downstream face of the dam, apparently the result of overtopping (see Photo Nos. 8, 9, 10, 11). Heavy brush and tree growth covers the embankment. The horizontal and vertical alignments of the crest are good. Surface cracks about 4 in. wide were observed on the crest between Stations 3+00 and 3+50 (see Photo No. 12). These cracks are believed to be associated with sloughing in that area. Shallow auger probes into the embankment indicated the dam to consist of a reddish brown silty clay with rock fragments. Information from the owners indicated that borrow material for construction of the embankment was obtained from the hillside on the north side of the dam.

The embankment surface is covered by heavy brush and small tree growth, which made it difficult to conduct a thorough investigation of the downstream face. Erosion channels are present at the abutment-dam contacts and in some areas of the downstream face. No wave protection is provided for the upstream face of the dam. No instrumentation (monuments, piezometers, etc.) was observed. No obvious seepage through the embankment was noted, although the dense tree and brush growth made it very difficult to thoroughly inspect the downstream face of the dam. In addition, the pond at the toe of the embankment prevented inspection for seepage in this area.

C. Appurtenant Structures:

C.1 Primary Spillways:

The approach channel to the south spillway contains brush and debris which cover the pipe entrance (see Photo No. 17). Cracking of the concrete in the spillways was noted, and some leakage was observed under the north spillway (see Photo No. 15). A small plunge pool has eroded below the north spillway. The discharge channels of the spillways contain brush and debris (see Photo Nos. 16 & 19).

C.2 Emergency Spillway:

No emergency spillway is associated with R. Haas & A. Heck Lake Dam.

D. Reservoir:

The watershed is generally wooded, with no agricultural activity. The slopes adjacent to the lake are moderate, and no sloughing or serious erosion was noted.

E. Downstream Channel:

The discharge channels of the spillways contain brush and debris.

3.2 EVALUATION:

Trees and brush on the dam are potential seepage hazards and encourage animal burrowing. Vegetation and debris in the approaches to the spillways can restrict flood flows. The erosional areas and sloughs on the embankment adversely affect the mass stability of the dam. Lack of wave protection for the upstream face of the dam can lead to serious erosion problems. The cracking of the concrete in the spillways could worsen and endanger these structures. Brush and debris in the outlet channels restrict the passage of flood flows.

All of these deficiencies should be corrected; however, vegetative growth is of such size and extent that removal should be attempted only under the direction of and with observation by an engineer experienced in the design and construction of dams. Indiscriminate clearing could create an unsafe condition.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam. The spillways are uncontrolled, so that the pool is normally controlled by rainfall, runoff and evaporation. The 2 in. pipe, which passes through the dam and discharges water into the pond below the embankment, carries such a small volume of water that its effect on the pool level is negligible.

4.2 MAINTENANCE OF DAM:

The abundant brush and tree growth and numerous erosional areas indicate that the dam has not been maintained in recent years.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities for this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The trees, brush, erosional areas, and sloughs on the embankment and in the spillways are serious deficiencies which should be corrected; however, these should only be accomplished under the direction of an experienced engineer to avoid creating an unsafe condition.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. The owners indicated that the dam had been overtopped twice since they have had possession. The most recent overtopping occurred in April 1979. No previous hydraulic or hydrologic studies were obtained. Our hydrologic and hydraulic analyses using U. S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

The brush and debris in the approaches and outlet channels of the spillways can restrict flood flows. The cracks in the concrete at the spillways could worsen and lead to failure of these structures.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the combined spillways will pass 6 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the small size of the dam, the low impoundment capacity of the reservoir and the large floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The structure will not pass a 100-year frequency flood without overtopping. The spillways will pass a 10-year frequency flood without overtopping.

The routing of 50 percent of the PMF through the spillways and dam indicates that the dam will be overtopped by 2.46 ft at elevation 103.46. The duration of the overtopping will be 6.58 hours, and the maximum outflow will be 5336 cfs. The maximum discharge capacity of the spillways is 359 cfs.

Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. Although the silty clay material which comprises the embankment is not considered highly erodible, significant damage or failure would be expected, considering the height and duration of overtopping that would result from the design flood.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The post-construction changes include installing the spillway pipes and box culvert in 1969 and 1970. In about 1974, a small pond was constructed near the downstream toe of the embankment.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in poor condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) considerable erosion and sloughing of the downstream face of the embankment; (2) heavy brush and tree growth on the dam; (3) erosion at the abutment-dam contacts; (4) lack of wave protection for the upstream face of the dam; (5) cracking of concrete at spillway locations; (6) brush and debris in spillway approach and outlet channels; (7) leakage under the north spillway; and (8) serious inadequacy of spillway capacity.

The dam will be overtopped by flows in excess of 6 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and will become even more serious in the future. Priority should be given to increasing the size of the spillway.

D. Necessity for Phase II:

Based on the results of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

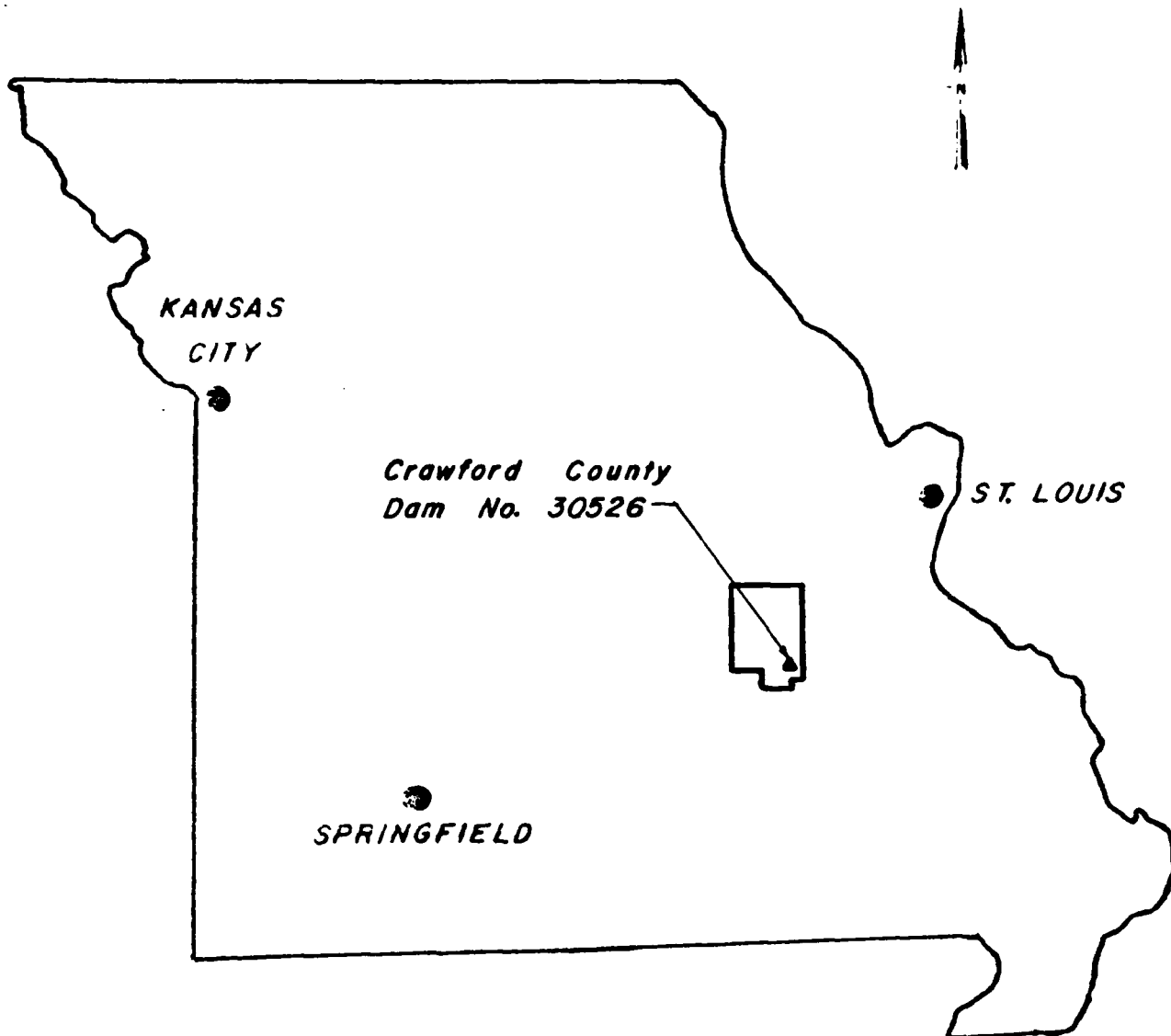
7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

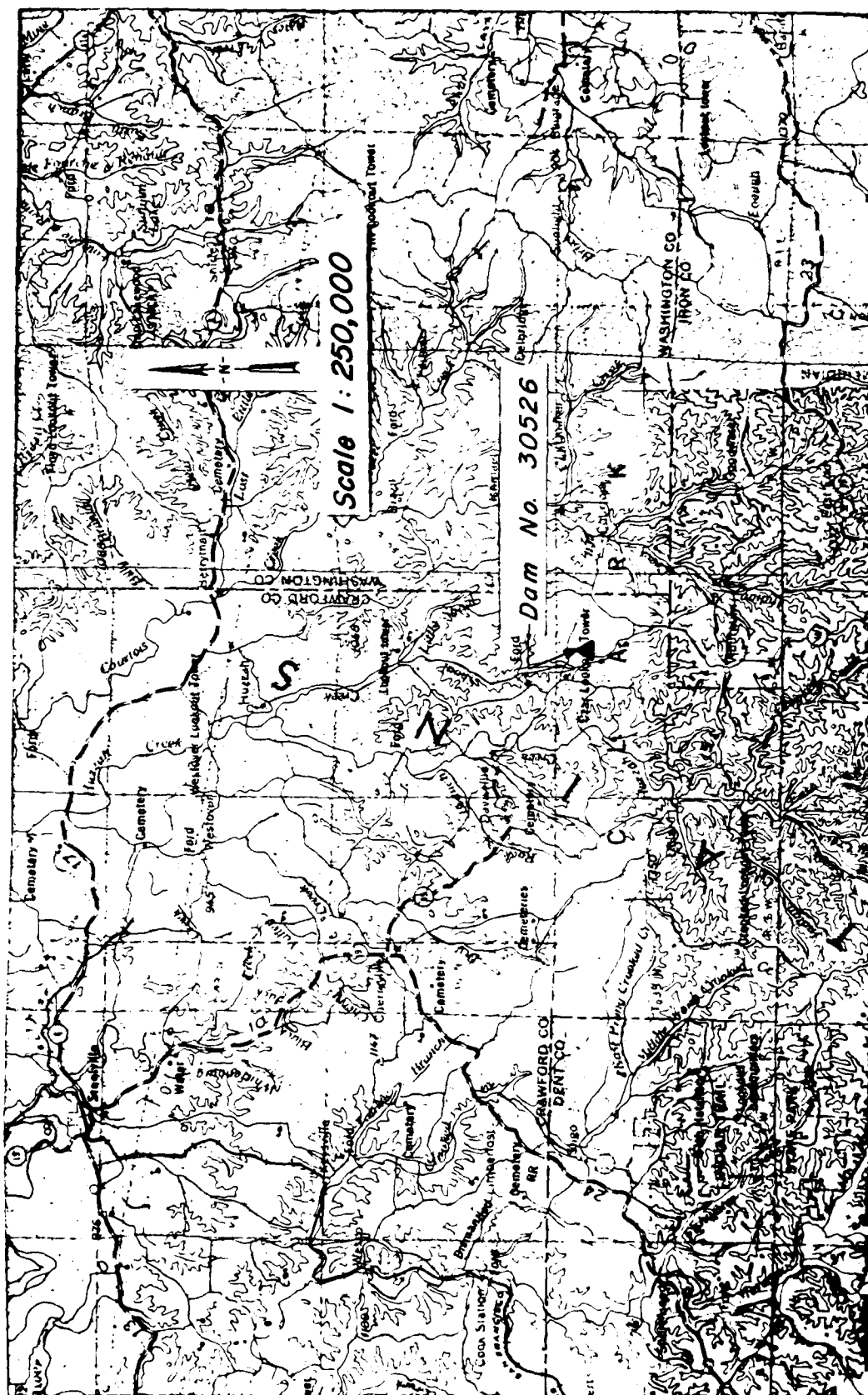
- (1) Spillway size and/or height of dam should be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.
- (2) Erosional areas and sloughs as previously discussed should be repaired and maintained.
- (3) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.
- (4) Brush and tree growth should be removed from the dam and from the spillway approach and outlet channels. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam. Brush and tree growth should then be removed from the dam on an annual basis.
- (5) Wave protection for the upstream face of the embankment should be provided.

- (6) The concrete in the spillways should be repaired, and the leakage under the north spillway should be sealed.
- (7) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

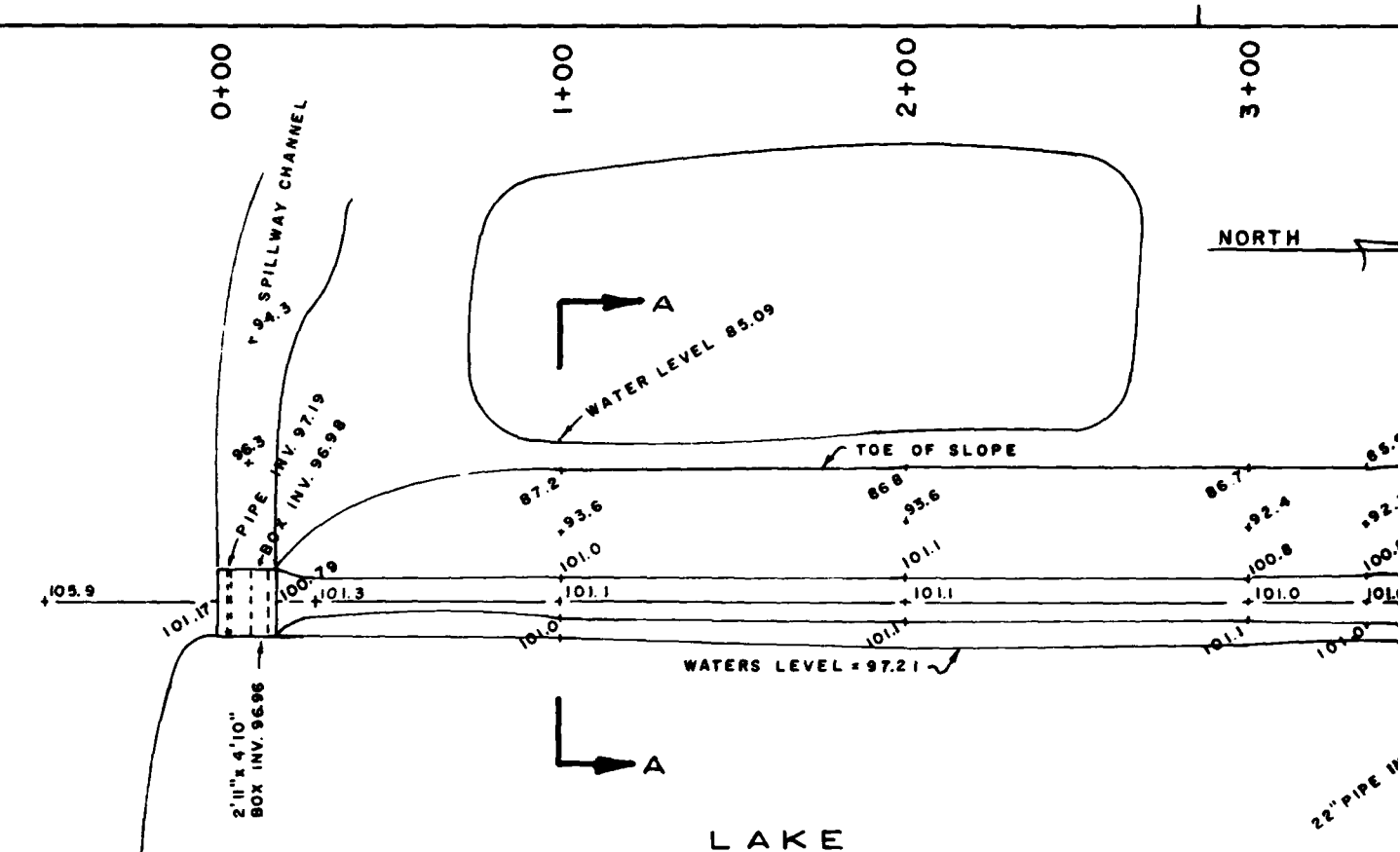
APPENDIX A



LOCATION MAP

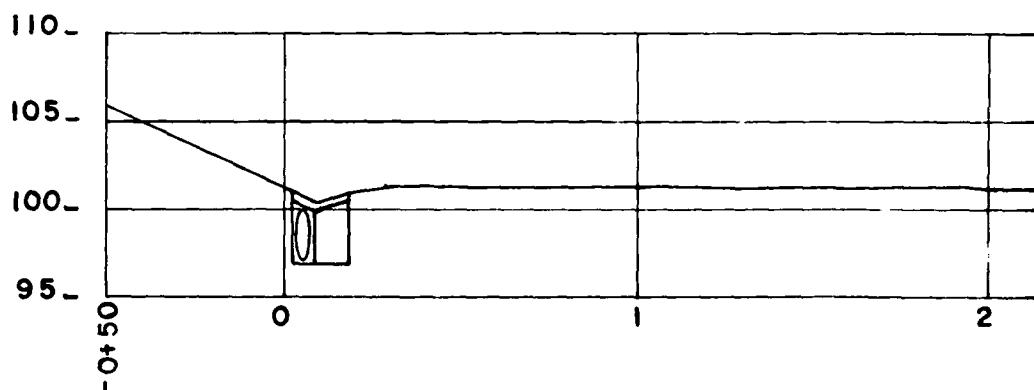


SITE VICINITY MAP



BENCHMARK:
TOP NE CORNER OF
NORTH CONCRETE CULVERT
ELEV. = 100.00

PLAN VIEW
SCALE: 1" = 50'

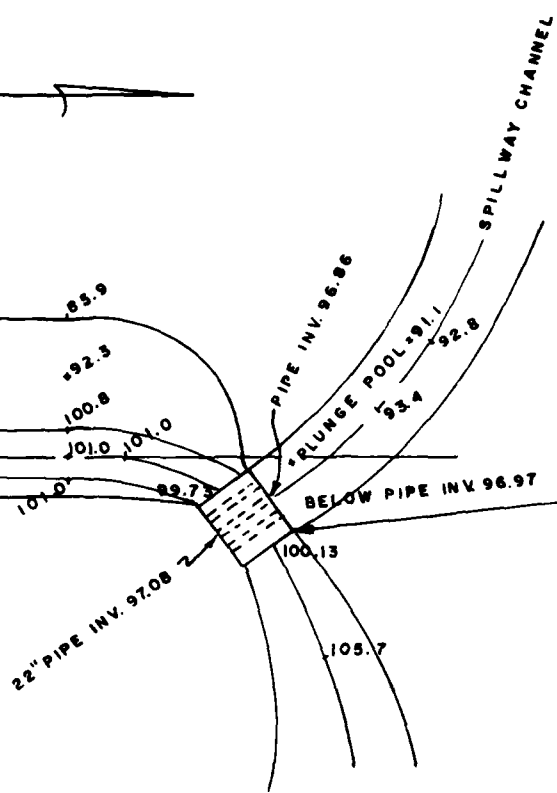


PROFI

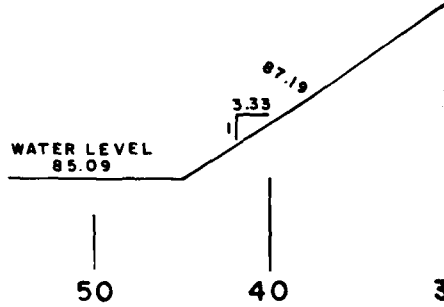
3+00

4+00

NORTH

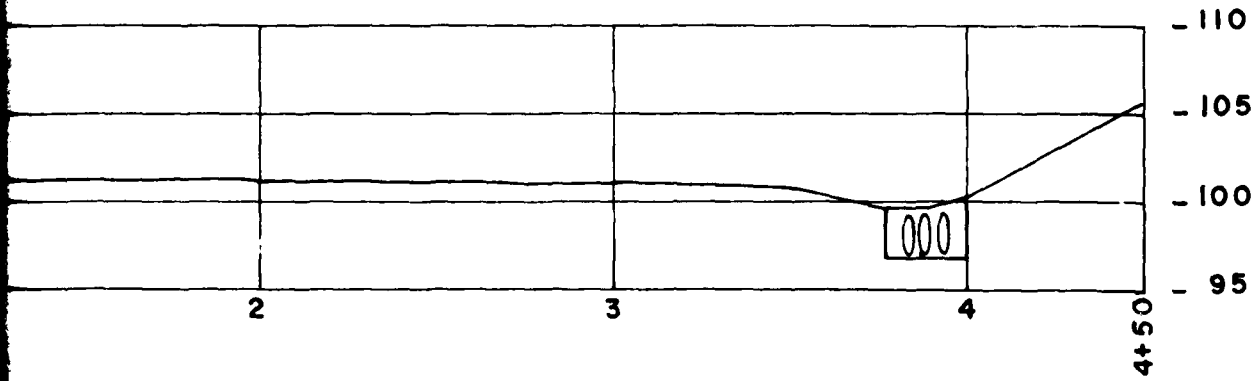


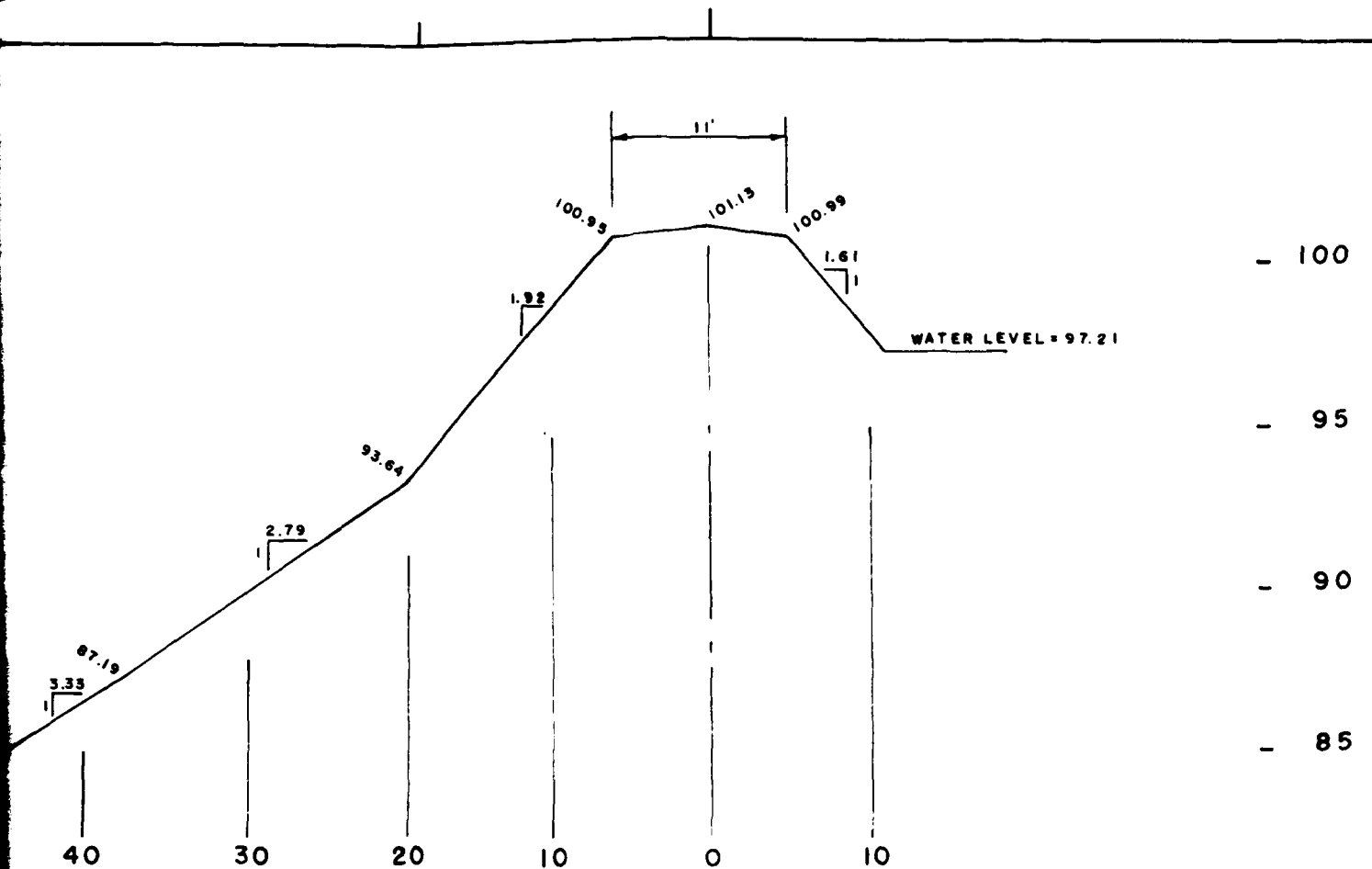
BENCHMARK :
TOP OF NORTHEAST
CORNER OF CONCRETE
CULVERT ASSUMED
ELEV. 100.00



SE

PROFILE





SECTION A-A STA 1+00

SHEET 3 APPENDIX A

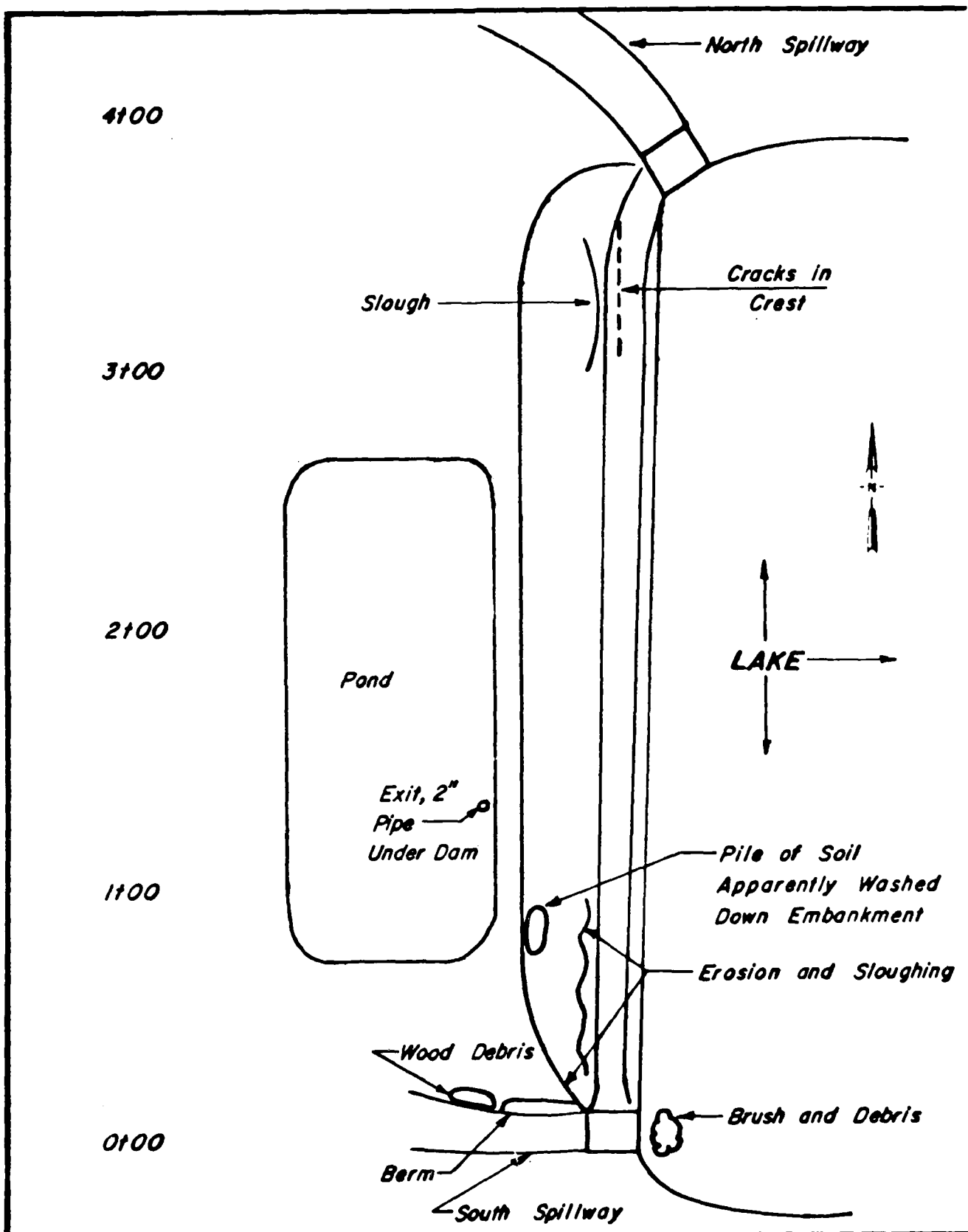
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

R. HAAS & A. HECK DAM

MO. No. 30526

PLAN & PROFILE

CRAWFORD COUNTY, MO.



DRAWN **DER**
 CHECKED **DED**
 DATE **7-19-79**
 JOB NO **79511**



**HANSON
 ENGINEERS**

SPRINGFIELD ILL

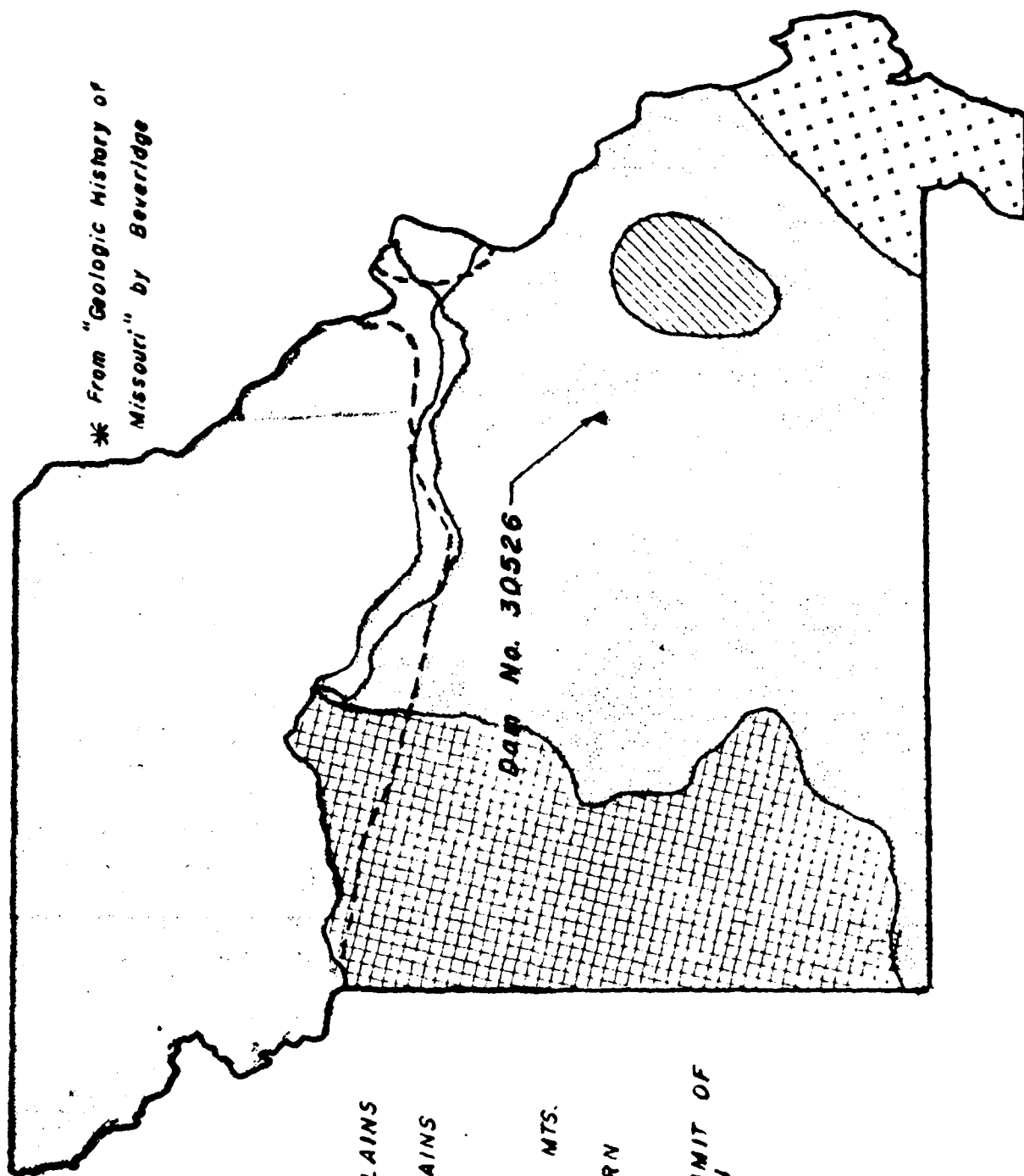
PEORIA ILL

Plan Sketch
Inspection Observations
Sheet 4 Appendix A

APPENDIX B

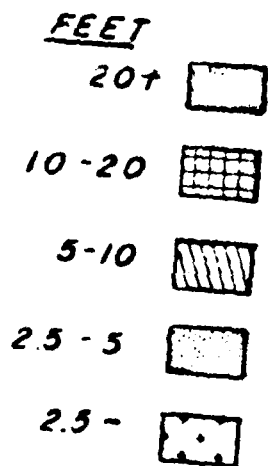
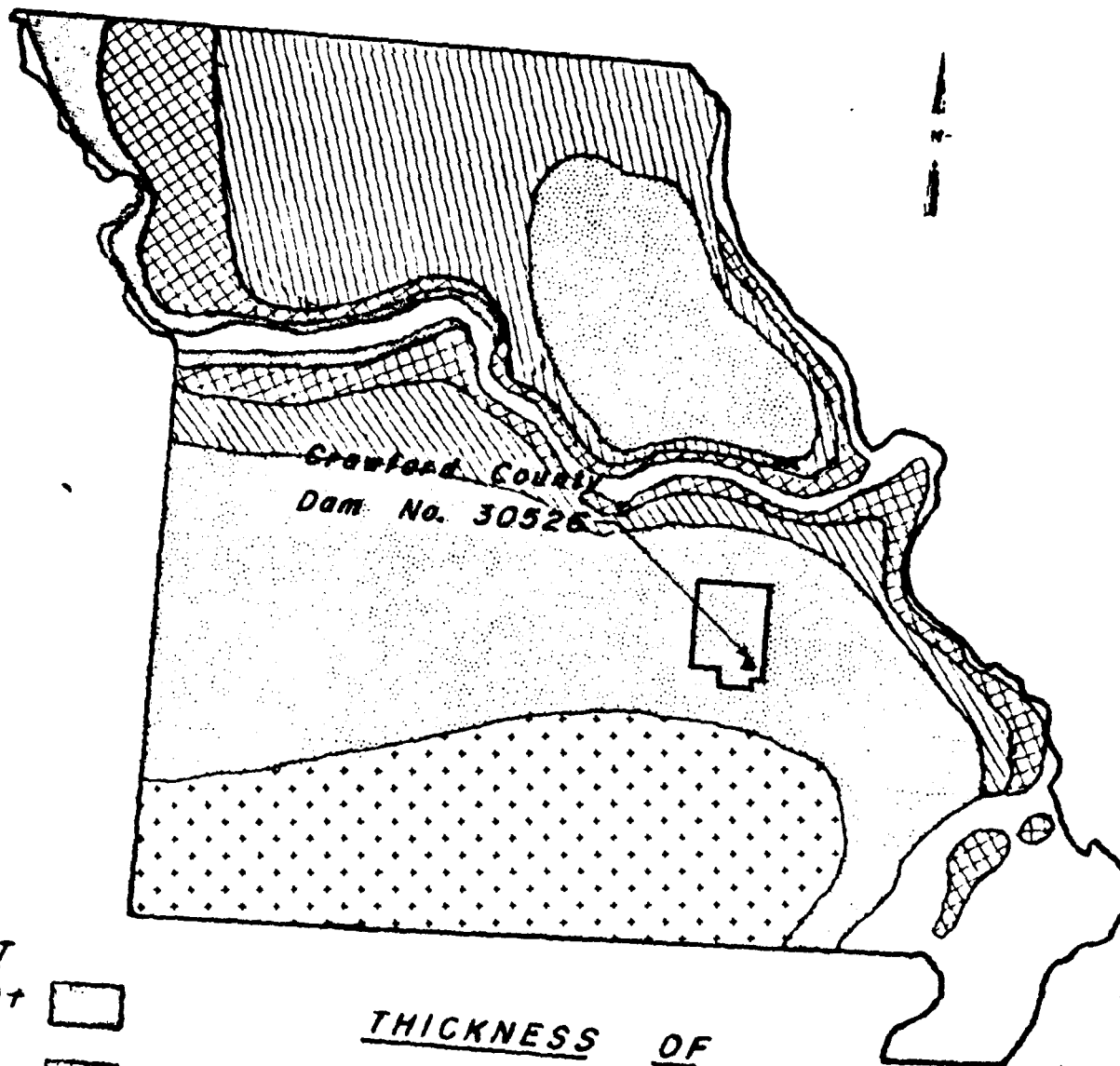
MAJOR GEOLOGIC REGIONS OF MISSOURI

* From "Geologic History of Missouri" by Beveridge



- GLACIATED PLAINS
- WESTERN PLAINS
- OZARKS
- ST. FRANCOIS MTS.
- SOUTHEASTERN LOWLANDS
- SOUTHERN LIMIT OF GLACIATION

* From "Soils of Missouri"



THICKNESS OF
LOESSIAL DEPOSITS

SHEET 2 OF APPENDIX B

APPENDIX C

HYDRAULIC AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. A co-owner, Mr. Robert Haas, indicates that the dam has been overtopped twice, including April 1979. There was indication of heavy erosion on the downstream face of the dam due to overtopping. On the day of the inspection, there were no indications of high water marks.

Visual Inspection: At the time of the inspection, the pool level was approximately 0.25 ft above normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by planimeter from the U.S.G.S. Davisville and Courtois, Missouri 7.5 minute quadrangle maps (advance prints). The storage volume was developed from these data. A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 1597 c.f.s. and a time to peak of 20 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 11,020 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the combined spillways will pass 6 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering the small volume of water impounded, the small height of the dam, and the large floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood.

The routing of 50 percent of the PMF through the spillways and dam indicates that the dam will be overtopped by 2.46 ft at elevation 103.460. The duration of the overtopping will be 6.58 hours, and the maximum outflow will be 5336 c.f.s. The maximum discharge capacity of the combined spillways is 359 c.f.s. Analysis of the data indicates that the 100-year frequency flood will overtop the dam.

The 10 year frequency flood was also routed through the spillway. The result indicates that the dam will not be overtopped by such an event.

The computer input, output and hydrographs for 50 percent of the PMF are presented at the end of this Appendix.

OVERTOPPING ANALYSES FOR R. HAAS & A. HECK LAKE DAM

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are As Follows:
 - a. Twenty-four Hour Rainfall of 26.7 Inches
For 200 Square Miles - All Season Envelope
 - b. Drainage Area = 721 Acres; = 1.13 Sq. Miles
 - c. Travel Time of Runoff 0.50 Hrs.; Lag Time 0.30 Hrs.
 - d. Soil Conservation Service Soil Group B
 - e. Soil Conservation Service Runoff Curve No. 75 (AMC III)
 - f. Proportion of Drainage Basin Impervious 0.02
2. Spillways
 - a. Primary Spillway: 2 ft 11 in. x 4 ft 10 in. Box
Culvert and one 22 in. I.D. steel pipe
 - b. Emergency Spillway
Three 22 in. I.D. steel pipes
 - c. Dam Overflow
Length 315 Ft.; Crest El. 101.0; C = 3.0
3. Spillway and Dam Rating:

Curve Prepared by Hanson Engineers. Data Provided
To Computer on Y4 and Y5 Cards.

Methods Use:

Flow Through Spillways: Culvert and Pipe Charts,
Flow Over Spillways: Broad Crested Weir $Q = CLH^{1.5}$,
C = 3.1

Note: Time of Concentration From Equation $T_c = \left(\frac{11.9 L^3}{H} \right)^{.385}$
California Culvert Practice, California Highways and
Public Works, Sept. 1942.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 1597 c.f.s.
 - b. Time to Peak 20 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow
50% PMF 5,510 c.f.s.; 100% PMF 11,020 c.f.s.
 - b. Peak Elevation
50% PMF 103.46 100% PMF 104.99
 - c. Portion of PMF That Will Reach Top of Dam
6 %; Top of Dam Elev. 101.0 Ft.
3. Computer Input and Output Data are shown on the following sheets of this Appendix.

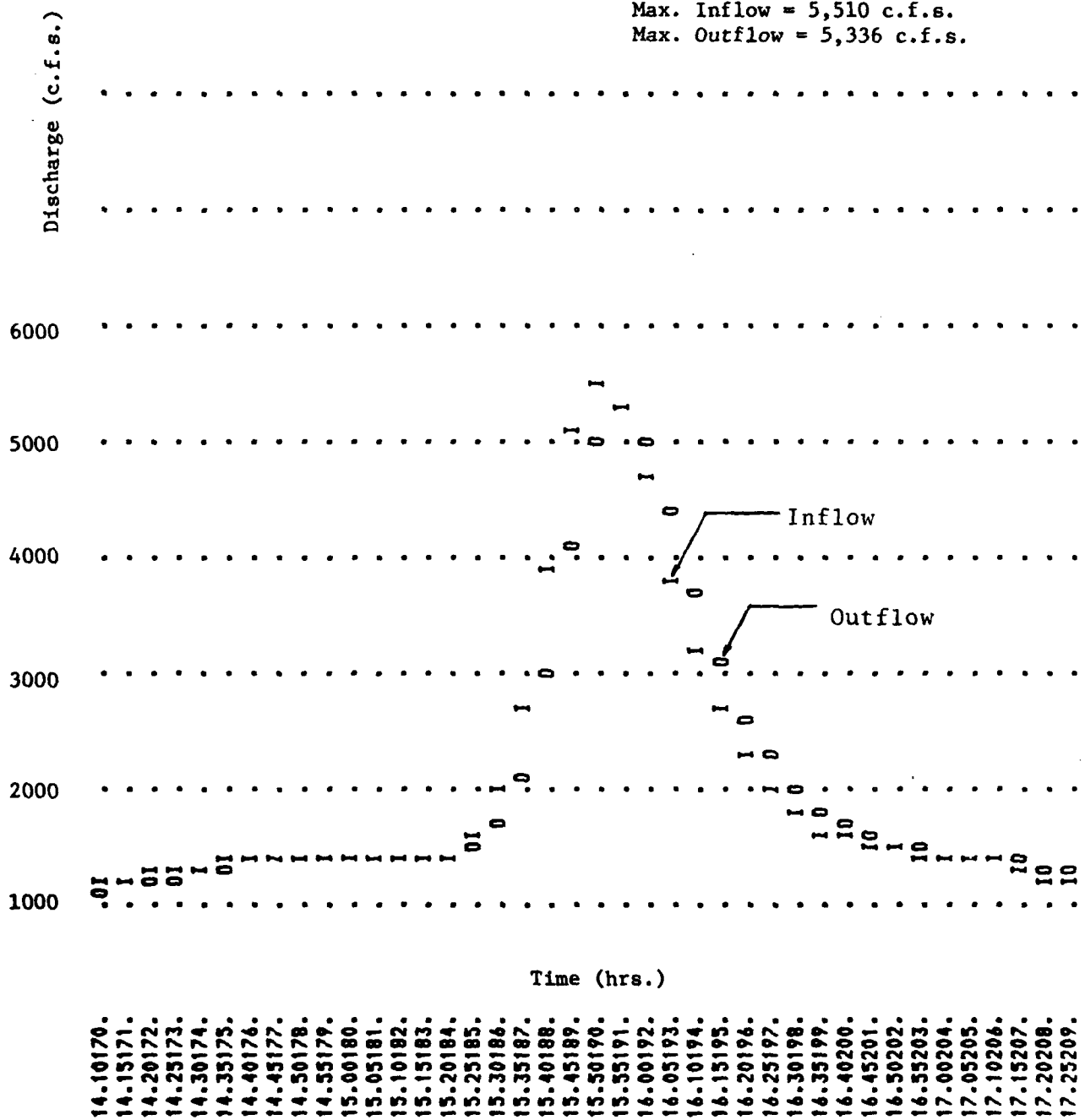
PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
				0.10	0.15	0.20	0.30	0.40	0.50	0.75	1.00
HYDROGRAPH AT	1	1.13	1	1102.	1653.	2204.	3306.	4408.	5510.	8265.	11020.
	(	2.93)	(	31.20)	46.81)	62.41)	93.61)	124.82)	156.02)	234.04)	312.05)
ROUTED TO	2	1.13	1	943.	1518.	2074.	3158.	4248.	5336.	8054.	10756.
	(	2.93)	(	26.71)	42.98)	58.73)	89.44)	120.28)	151.09)	228.05)	304.58)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1													
ELEVATION		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM		TIME OF		TIME OF		TIME OF	
STORAGE								MAX OUTFLOW		DURATION		FAILURE	
OUTFLOW								HOURS		OVER TOP		HOURS	
								CFS		HOURS		HOURS	
								AC-FT					
								MAXIMUM					
								STORAGE					
								AC-FT					
								MAXIMUM					
								DEPTH					
								OVER DAM					
								U.S.ELEV					
								MAXIMUM					
								RESERVOIR					
								U.S.ELEV					
								MAXIMUM					
								STORAGE					
								AC-FT					
								MAXIMUM					
								OUTFLOW					
								CFS					
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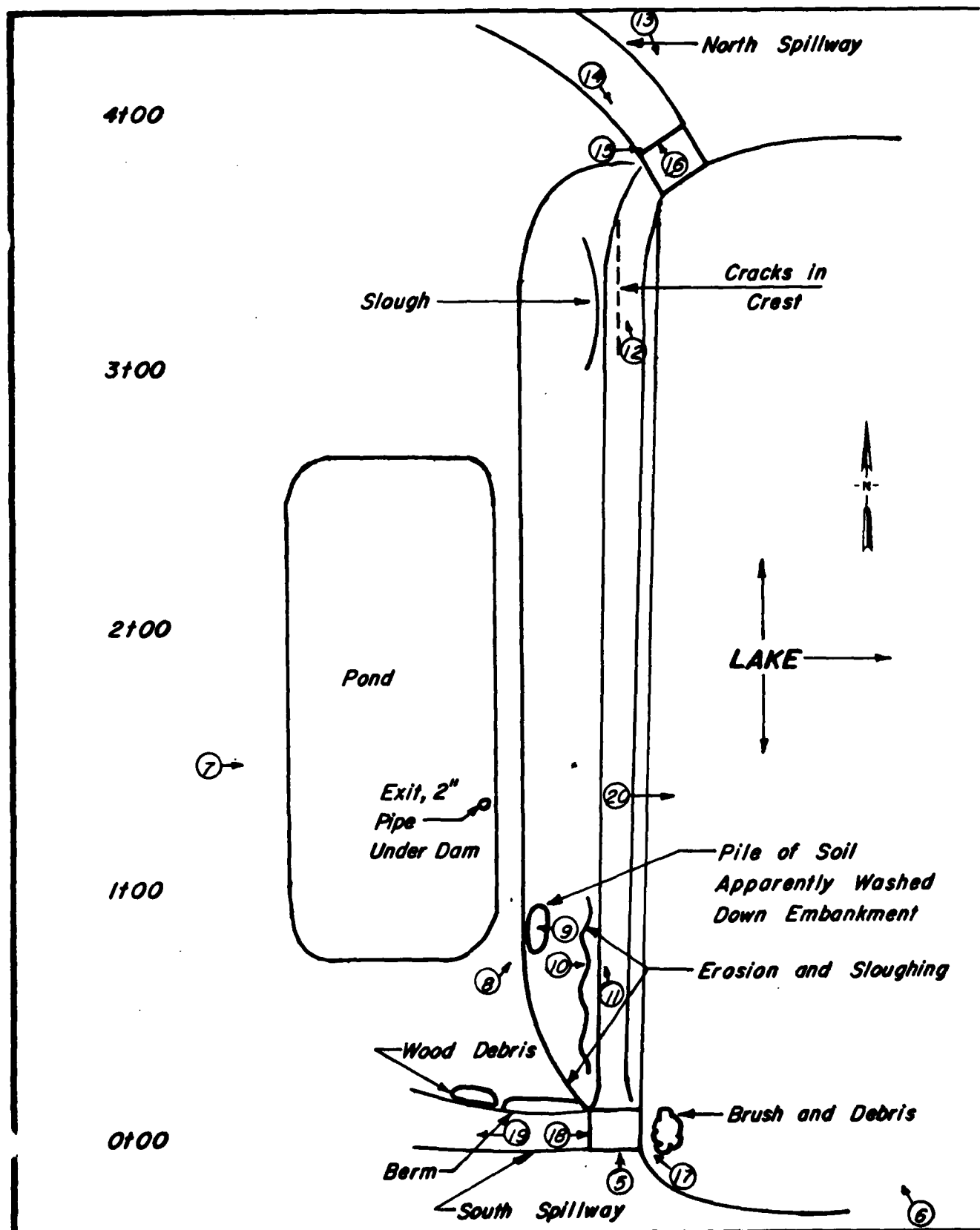
INFLOW - OUTFLOW
HYDROGRAPH
FOR 50% P.M.F.



APPENDIX D

INDEX TO PHOTOGRAPHS

<u>Photo No.</u>	<u>Description</u>
1.	Aerial - Lake and Dam, Looking South
2.	Aerial - Looking South, Note Pond at Downstream Toe
3.	Aerial - Looking at Spillway, North Abutment
4.	Aerial - Looking at Downstream Face, Note erosion near South Abutment
5.	Crest of Dam - Looking North
6.	Upstream Face - Looking Northwest
7.	Downstream Face - Looking East Across Pond - Note Water Emerging From Pipe Under Dam Near Toe
8.	Erosional Area on Downstream Face at Station 1+00
9.	Eroded Material Deposited at Base Dam on Downstream Face - Looking Downstream Towards Pond - Near Station 1+00
10.	Eroded Area on Downstream Face Near Crest at Station 1+00
11.	Erosional Trench (1.5 ft deep) Near Crest on Downstream Face Near Station 1+00
12.	Vertical Crack Associated With Apparent Slope Failure on Downstream Face Between Station 3+00 and 3+50
13.	North Abutment Spillway
14.	North Abutment Spillway - Looking Upstream
15.	Seepage Under North Abutment Spillway
16.	North Abutment Spillway - Looking Downstream
17.	South Abutment Spillway Entrance - Note Debris Blocking Pipe Section
18.	South Abutment Spillway Exit - Looking Upstream
19.	South Abutment Spillway Outlet - Looking Downstream
20.	Lake Area - From Crest of Dam



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 CHECKED DED
 DATE 7-19-79
 JOB NO 79511

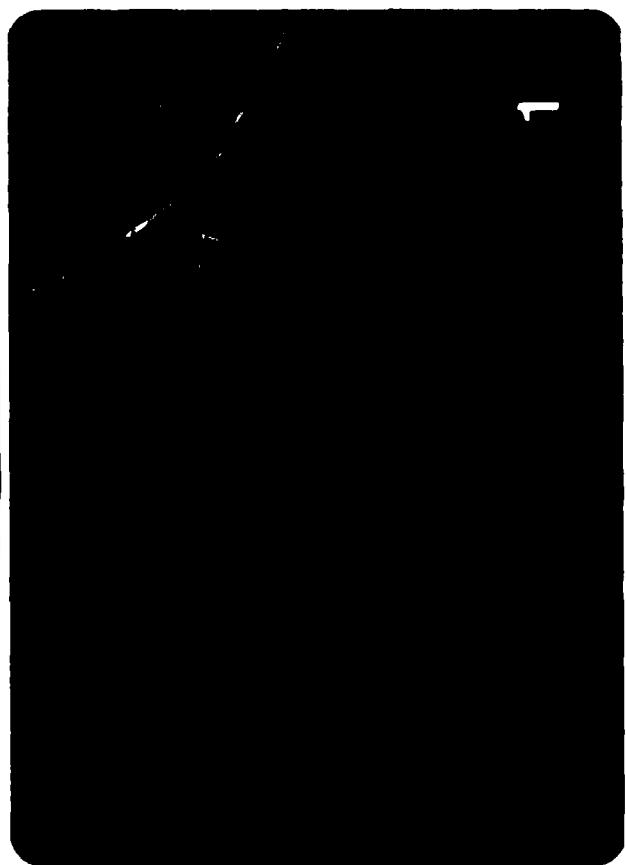
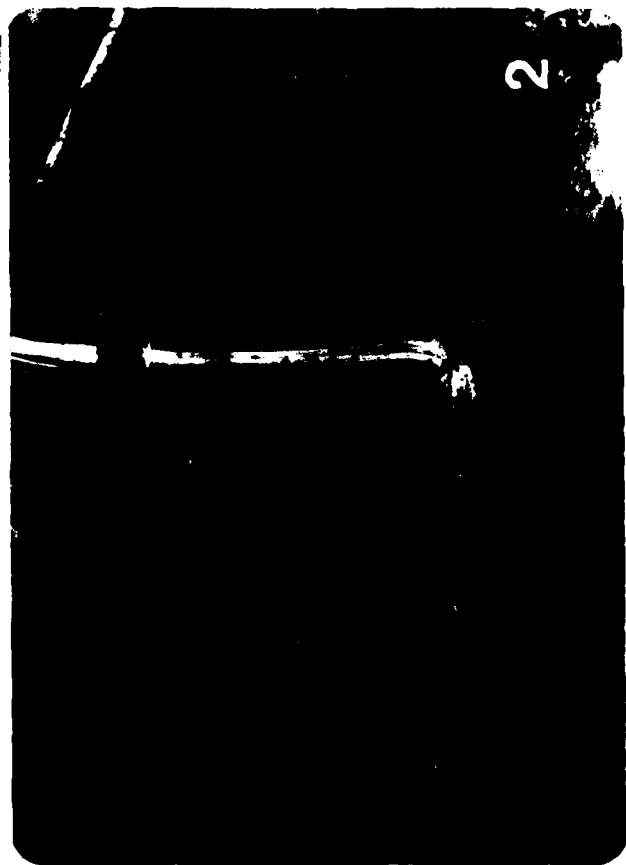


HANSON
 ENGINEERS
 INC.

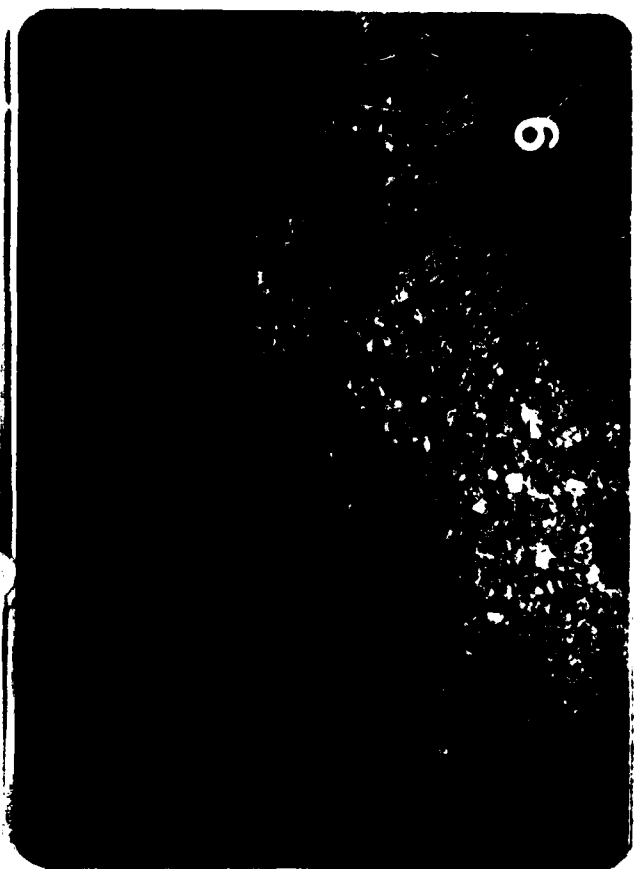
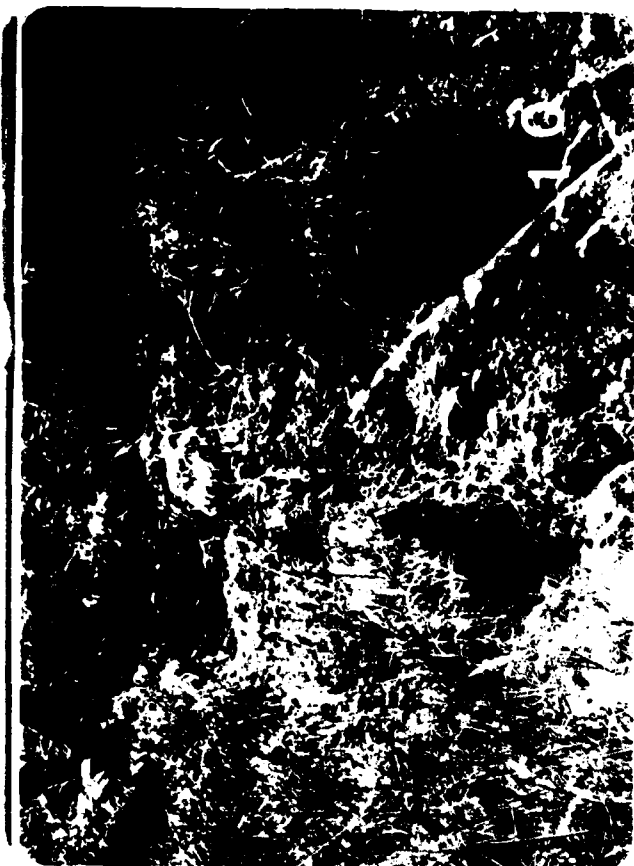
SPRINGFIELD ILL.

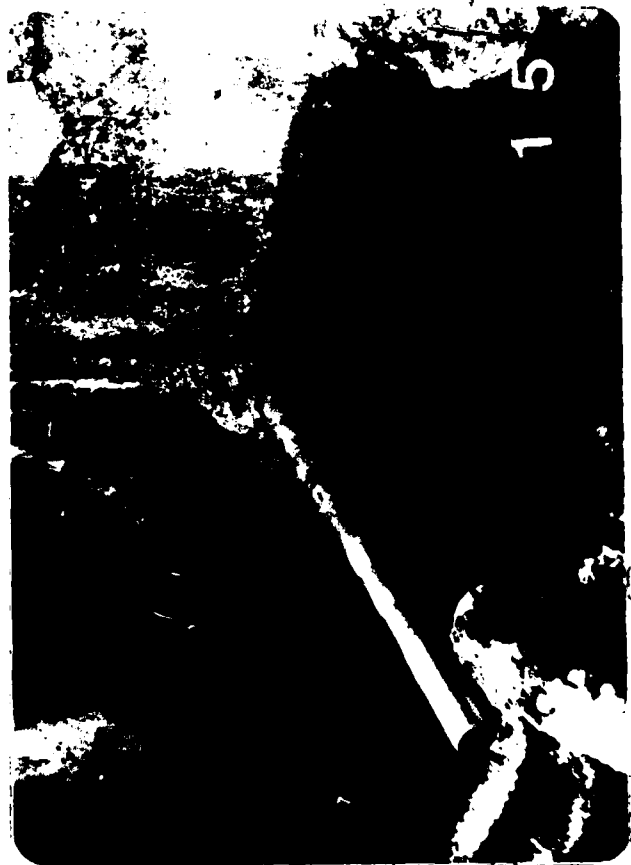
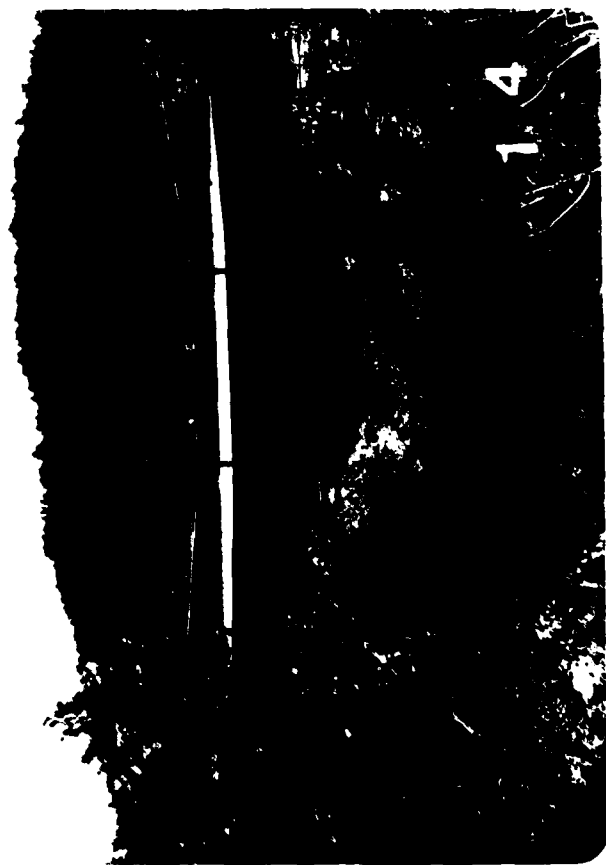
PEORIA ILL.

Plan Sketch
 Key To Photographs
 Sheet 2 Appendix D











20



17



19

DATE
ILME